APPENDIX E

EXECUTIVE SUMMARY – QUADRANT II CAS/CMS

DOE/OR/12-1223&D5

Quadrant II
Cleanup Alternatives Study/Corrective Measures Study
Final Report

for

Portsmouth Gaseous Diffusion Plant
Piketon, Ohio

February 28, 2001

This document has received appropriate
reviews for release to the public.

DOE/OR/12-1223&D5

Quadrant II
Cleanup Alternatives Study/Corrective Measures Study
Final Report

For

Portsmouth Gaseous Diffusion Plant
Piketon, Ohio

Date Issued—February 28, 2001

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EXECUTIVE SUMMARY

This report presents the results of the Cleanup Alternatives Study/Corrective Measures Study (CAS/CMS) conducted for Quadrant II of the Portsmouth Gaseous Diffusion Plant (PORTS) located near Piketon, Ohio. PORTS currently enriches uranium for electrical power generation and until 1991 provided highly enriched uranium to the United States Navy. The U.S. government began production of enriched uranium at PORTS in the mid-1950s. The production facilities are owned by the U.S. Department of Energy (DOE) and have been leased to the United States Enrichment Corporation since July 1, 1993. Portions of the site are leased to the Ohio Army National Guard. The leased land use is industrial and will remain industrial for some time in the future. Industrial land use includes 1,000 acres of the federal reservation. Portions of PORTS outside of the security fence may be developed for commercial or recreational use in the future.

The environmental restoration program at PORTS is the subject of two enforcement actions. The State of Ohio issued a Consent Decree August 31, 1989, in accordance with the Resource Conservation and Recovery Act (RCRA) and its implementing regulations; the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980; the National Contingency Plan (NCP); and applicable U.S. Environmental Protection Agency (U.S. EPA) policy. The U.S. EPA Region V issued an Administrative Consent Order (ACO) September 27, 1989, (amended May 11, 1994, and August 11, 1997) under the authority of Section 3008(h) of the RCRA of 1976. The Ohio Consent Decree requires a CAS and the U.S. EPA Administrative Order by Consent requires a CMS. The Ohio Environmental Protection Agency (Ohio EPA) and U.S. EPA have agreed to a single document, a CAS/CMS report, to fulfill the requirements for these essentially equivalent deliverables. A second amendment to the ACO executed August 11, 1997, relinquished day-to-day oversight of response action activities at PORTS to the Ohio EPA.

Because long-term surveillance, maintenance, and institutional controls will continue indefinitely, future uses of the site are limited and continuation of industrial activity is assumed. Continued industrial use of the PORTS facility is important for the Southern Ohio economy. Stakeholder discussions to date have resulted in the identification of preferred options to maintain industrial land use within the security fence and mixed industrial/commercial and potentially recreational land use in those areas of the federal reservation outside the security fence. Stakeholders have not recommended future residential land use development for PORTS.

The environmental restoration program included the formation of a Decision Team consisting of Ohio EPA, U.S. EPA, and DOE representatives to expedite decisions regarding technical and regulatory issues. Sitewide remediation strategies are influenced by Decision Team actions and supporting policy documents.

DOE evaluated the as low as reasonably achievable (ALARA) principles, considered current and future projected land use, reviewed best available technologies, and examined cleanup levels that have been established at other sites. Consideration of future land use and the ALARA process should be a pivotal part of the final selection of appropriate remedial alternatives for PORTS solid waste management units (SWMUs).

The PORTS Decision Team developed a system to categorize each SWMU on the basis of current and realistic future risk (excluding the future on-site resident exposure scenario) as determined by analyzing data from the RCRA Facility Investigation (RFI) Baseline Risk Assessment. Because both soil and groundwater in portions of Quadrant II are contaminated at levels exceeding acceptable risk, remedial action alternatives must be developed for the following SWMUs:

- X-701B Holding Pond and Retention Basins (Soils), and
- X-701B Groundwater Area.

The 7-Unit Groundwater Area contains contamination levels exceeding acceptable risk. However, the complete investigation of the 7-Unit plume cannot be completed at this time due to its location within the current industrial area. It is currently being contained and treated; therefore, there is no immediate threat to human health or the environment. The X-701C Neutralization Pit and soils in the area of the X-720 Neutralization Pit have been identified as potential source areas, and actions in these areas are outlined in this report. Source identification activities will continue through routine monitoring until additional investigation can be performed at Decontamination and Decommissioning (D&D).

A limited soil removal will be employed south of the former X-720 Neutralization Pit to eliminate inorganic contaminants exceeding soil PRGs. The excavation will then be backfilled and a concrete cover placed over the area.

A Director's Final Findings and Orders (DFF&Os) was journalized on March 18, 1999, to integrate several RCRA units into the CAS/CMS process. In Quadrant II, these units are the X-701C Neutralization Pit, the X-744Y Waste Storage Yard, the X-230J7 East Holding Pond and Oil Separation Basin, and the X-701B Holding Pond. As noted above, the X-701B Holding Pond soils and groundwater require development of remedial action alternatives. The X-701C Neutralization Pit will be removed.

At X-230J7, although the ELCR of 1×10^{-6} has been exceeded, remediation at this time would be neither more protective of human health and the environment nor economically responsible at this stage in the life cycle of the PORTS facility. Therefore, remediation of soils and sediment at this unit will be deferred to PORTS D&D. Groundwater data for X-230J7 has been evaluated as part of the X-701B Groundwater Area.

The substantive requirements of RCRA have been met for soils at the X-744Y Waste Storage Yard, and the groundwater plume at the X-744Y Waste Storage Yard will be addressed as part of the X-701B plume in Chapter 7. The selected actions taken at all of these RCRA units will be implemented in accordance with the CMI Work Plan. Closure certification will be met when the CMI Final Report is submitted to the Ohio EPA. The post-closure requirements of RCRA will be contained in the Operation & Maintenance (O&M) Plan. Certification of completion of post-closure care will be met upon submittal of the O&M Monitoring Final Report.

The PORTS Quadrant II CAS/CMS process leads to the development of remedial alternatives. Evaluation and selection of appropriate remedial alternatives require establishment of remedial action objectives (RAOs). These RAOs are qualitative statements, not numerical cleanup targets, that provide the basis for both generating and evaluating remedial alternatives. Preliminary remediation goals (PRGs) were developed to assess the effectiveness of remedial actions used to meet RAOs. The PRGs were developed by using background values, regulatory criteria, and risk data.

A presumptive response strategy, developed by the U.S. EPA, defines response actions and remedies for sites with contaminated groundwater and presumptive technologies for ex situ treatment of contaminated groundwater. The contaminants and site conditions at PORTS are appropriate for the application of presumptive remedies suggested by the U.S. EPA. As recommended in the presumptive strategy guidance, this CAS/CMS streamlines the technology identification and screening steps and focuses on the evaluation of the presumptive remedy technologies.

Innovative treatment technologies for use in remediation of soil and groundwater and containment of groundwater plumes have been evaluated at PORTS and have been incorporated into remedial alternatives when their effectiveness has been demonstrated. New and innovative technologies will continue to be evaluated as appropriate applications are identified.

X-701B HOLDING POND AND RETENTION BASINS (SOILS)

The X-701B Holding Pond was an unlined 200 ft by 50 ft pond used for the neutralization and settling of metal-bearing and acidic wastewater. The X-701B Holding Pond was in use from 1954 until November 1988 and was regulated as an NPDES outfall between August 1983 and September 1991. Most of the waste discharged to the pond originated at the X-700 Chemical Cleaning Facility and the X-705 Decontamination Building. From 1974 until 1988, slaked lime was added to the X-701B influent at the X-701E Neutralization Facility to neutralize the low pH and induce precipitation. This precipitation caused large amounts of sludge to accumulate in the pond and necessitated periodic dredging of the sludge. The sludge recovered during dredging was stored in two retention basins located to the northwest of the pond.

The X-701B East and West Retention Basins were unlined sludge retention basins used for the settling, dewatering and storage of sludge removed from the X-701B Holding Pond. The East Retention Basin, built in 1973, was approximately 220 ft by 65 ft (narrowing to 25 ft wide in the northeast corner) and was 3.5 ft deep. The east basin was in use from 1973 until approximately 1980. The West Retention Basin was built in 1980, when the east basin reached capacity. The west basin was approximately 220 ft by 45 ft (narrowing to 35 ft wide in the northern portion) and was 3 ft deep. The west basin was in use from 1980 until 1988.

In 1989, PORTS initiated a two-phase closure of the unit. As part of the first phase, sludge was excavated from the holding pond and two retention basins. The sludge was dewatered, placed in containers, and transported to on-site storage. The retention basins were backfilled, graded and seeded. The second phase began in 1994, and included construction of a groundwater pump-and-treat system and in-situ treatment of soils in the bottom of the holding pond with thermally enhanced vapor extraction (TEVE). Limestone riprap and gravel were placed on the bottom of the holding pond to support the soil treatment equipment. Use of TEVE was terminated after it failed to achieve identified performance standards. However, the limestone riprap and gravel material currently remains in the holding pond, and a gravel access road remains on the southeast side of the holding pond. Two pumps in a sump located in the low point of the holding pond remain operational. The water removed by these two pumps is transferred, via underground piping, directly into the X-623 Groundwater Treatment Facility.

During 1997 and 1998, an investigation in the X-701B Retention Basin area revealed that the saturated fill material in the retention basins was contaminated with uranium and technetium at concentrations that exceed PRGs. In addition, detectable concentrations of transuranics were discovered. The higher radionuclide concentrations found in the fill material are believed to be the result of incomplete removal of sludge during initial closure actions at the retention basins. Existing data does not indicate that radioactive contaminants are migrating from the retention basins to either surface water or groundwater at concentrations exceeding PRGs.

The X-701B Holding Pond and Retention Basins were integrated into the CAS/CMS process in the DFF&Os journalized on March 18, 1999.

A range of potentially viable remedial alternatives has been assembled for the X-701B Holding Pond and Retention Basins by using representative process options. All alternatives were selected for their potential to meet RAOs, address all environmental problems, reduce overall risk, and protect human health and the environment. An alternative has been assembled for each of the following categories: institutional controls, removal, and capping. The remedial alternatives for soils at the X-701B Holding Pond and Retention Basins are as follows:

- Alternative 1 - Institutional Controls

  Deed restrictions to limit land development and access controls to prevent exposure to contaminated soils are included in this alternative.

- Alternative 2 - Institutional Controls and Removal

  Future land use at the area associated with the X-701B Holding Pond and Retention Basins would be limited to commercial/industrial activities through deed restrictions that would prevent development of the excavated area. Contaminated soil would be removed to the base of the retention basins and to depths where contaminants exceed their PRG. The horizontal extent of contamination would be addressed by excavating 2 ft beyond the edges of the retention basins and 10 ft from data points in the holding pond where contaminants exceed PRGs. Excavated soil would be evaluated to determine the proper disposal method, but is assumed to be a mixed waste in this report.

- Alternative 3 - Institutional Controls, Select Removal and Capping

  Select solids excavation and backfilling in conjunction with capping is highly effective and implementable. This alternative includes installation of a multimedia cap system over the X-701B Holding Pond and Retention Basins. There would be selected excavation of soil in outlying areas where there have been sporadic detections of contaminants. Institutional controls include deed and access restrictions.

Table ES.1 summarizes the relative effectiveness and costs for the X-701B Holding Pond and Retention Basins alternatives evaluated.

Alternative 1 will not meet all RAOs because contaminant concentrations will not be reduced below established leaching levels. Alternatives 2 and 3 minimize both long-term and short-term risks to human health and the environment and will meet RAOs by eliminating the exposure pathway and reducing contaminant concentrations. All of these alternatives can be readily implemented and have been proven reliable and effective.

X-701B GROUNDWATER AREA

This area of groundwater contamination extends east from the vicinity of the former X-701B Holding Pond to the vicinity of Little Beaver Creek. The plume width does not exceed 300 ft. TCE concentrations in the most contaminated portions of this plume exceed 100,000 ug/L.

A comprehensive series of model simulations incorporating various remedial technologies, both alone and in combination, have been evaluated. These model simulations indicate that it is not practicable to move a sufficient quantity of water through the Gallia saturated zone to remediate groundwater and associated saturated soils to concentrations less than PRGs in all areas of the plumes within the targeted 30-year timeframe. Even with extensive application of best available technologies, the hydrogeologic conditions in this area preclude achieving the target risk level of 1×10^{-6} within 30 years. However, these simulations do indicate that groundwater contaminant levels can be reduced to an acceptable risk level of 1×10^{-5} in a much shorter timeframe, in effect attaining the concentrations which are as low as reasonably achievable given the constraints of the local hydrogeologic system.

The alternatives selected employ the best available technologies for this area of the PORTS site. Alternatives were selected for their potential to meet RAOs, address all environmental problems, reduce overall risk to acceptable levels, and protect human health and the environment. The no action alternative provides a baseline for comparison with active remedial measures. All alternatives, except for Alternative 1, include monitoring the effects of the remedial action chosen. The following are the remedial alternatives for the X-701B Groundwater Area.

Table ES.1. Summary of Alternative Analysis for X-701B Holding Pond and Retention Basins (Soils), Portsmouth Gaseous Diffusion Plant, Piketon, Ohio

Alternative	Technical Analysis	Human Health Analysis	Environmental Analysis	Institutional Analysis	Capital Cost Analysis (Present Worth - $1,000s)	O&M Cost (Present Worth - $1,000s)
1 – Institutional Controls	Readily implementable. Deed restrictions and existing fencing would be reliable if site controls are maintained.	No short-term risk. Long-term exposure to on-site workers.	No risk to environmental indicators.	Does not meet all RAOs and preliminary ARARs.	68	103
2 – Institutional Controls and Removal	Readily implementable. Removal of construction debris and associated soil followed by backfilling of the area.	Short-term risk to remediation workers. Long-term risk eliminated through elimination of the pathway.	No risk to environmental indicators. Could initially disrupt ecological receptors but is not expected to result in permanent effects.	Can meet all RAOs and preliminary ARARs.	4,012	103
3 – Institutional Controls, Select Removal and Capping	Readily implementable. Removal of select soil followed by capping the retention basin and holding pond areas.	Short-term risk to remediation workers. Long-term risk eliminated through elimination of the pathway.	No risk to environmental indicators. Could initially disrupt ecological receptors but is not expected to result in permanent effects.	Can meet all RAOs and preliminary ARARs.	1,820	103

The remedial alternatives for groundwater at the X-701B Groundwater Area include the following:

- Alternative 1 - No Action

  No actions are assumed for this alternative. No access and use restrictions, maintenance or monitoring is included.

- Alternative 2 - No Further Corrective Action

  This alternative includes groundwater/surface-water monitoring activities and basement sumps in the X-705 Decontamination Building that continue to operate. The X-701B IRM trench and the X-701B extraction system would also continue to operate.

- Alternative 3 - Oxidant Injection, Vacuum Enhanced Recovery (VER) and Phytoremediation

  This alternative includes an area of oxidant injection, an area of VER recovery wells, and an area of cultivation of poplar trees. Basement sumps in the X-705 Decontamination Building and the X-701B IRM trench would continue to extract contaminated groundwater for the entire 30-year model simulation.

- This alternative includes installation of an extraction/reinjection well network with treatment of extracted groundwater at the existing X-623 and X-624 facilities. Basement sumps in the X-705 building and the X-701B IRM trench would continue to extract contaminated groundwater for the entire 30-year model simulation.

- Alternative 4 - VER and Steam Stripping

  This alternative includes 24 VER wells with associated equipment that would operate for two years. Steam Stripping, which consists of a combination of steam injection and groundwater extraction wells, would be used to remove the volatile contaminants in the western portion of the X-701B Groundwater Area plume and would operate for two years. Basement sumps in the X-705 Decontamination Building and the X-701B IRM trench would continue to extract contaminated groundwater for the entire 30-year model simulation.

- Alternative 5 - VER

  Thirty-nine VER wells would be installed throughout the X-701B Groundwater Area plume. These wells would operate for two years at which time 25 of the wells continue operation for the remainder of the simulation. Basement sumps in the X-705 Decontamination Building and the X-701B IRM trench would continue to extract contaminated groundwater for the entire 30-year model simulation.

- Alternative 6 - Groundwater Extraction and Bioremediation

  Enhanced Bioremediation of the eastern portion of the X-701B Groundwater Area plume would be accomplished in the first two years of this simulation. Nine groundwater extraction wells located in the remaining areas of the plume would operate for the entire 30-year simulation. Basement sumps in the X-705 Decontamination Building and the X-701B IRM trench would continue to extract contaminated groundwater for the entire 30-year model simulation.

- Alternative 7 - Oxidant Recirculation

  Thirty extraction wells and 17 injection wells would be installed throughout most of the X-701B Groundwater Area plume. Contamination reduction would be achieved in the first six months of this simulation. Reduction would be accomplished by extracting groundwater, circulating it through the above ground oxidant injection system, and reinjecting the treated groundwater into the injection wells where the oxidant would reduce residual soil contamination as well as groundwater contamination. Basement sumps in the X-705 Decontamination Building and the X-701B IRM trench would continue to extract contaminated groundwater for the entire 30-year model simulation.

Table ES.2 summarizes the relative effectiveness and costs for the X-701B Groundwater Area alternatives.

Alternatives 3, 5, 6, and 7 meet all RAOs and would significantly reduce the overall mass of contaminants in the groundwater. Alternative 4 would meet all RAOs with the exception that COCs may impact surface water at X-230J7. Alternatives 3 through 7 would minimize both short-term and long-term risks to human receptors. Alternative 7 may pose additional short-term risks to ecological receptors in the area because oxidizing agents will be injected in areas that are adjacent to surface water bodies and could potentially migrate to surface water. All of the alternatives are readily implementable.

Table ES.2. Summary of Alternative Analysis for the X-701B Groundwater Area Portsmouth Gaseous Diffusion Plant, Piketon, Ohio

Alternative	Technical Analysis	Human Health Analysis	Environmental Analysis	Institutional Analysis	Estimated Maximum TCE Concentration at 30 years (Fg/L)	Estimated Maximum ELCR at 30 years	Estimated Remaining Plume Area Above PRGs (ft^2)	30 Year Present Worth Costs ($1,000s) Capital/ O&M
1 - No Action	Readily implementable. Not effective at reducing exposure to contaminants.	No short-term risk. Long-term exposure to on-site workers and off-site population.	No risk to environmental indicators.	Does not meet all RAOs and preliminary ARARs.	6,830	1.31 x 10^{-3}	2,800,000	0/0
2 - No Further Corrective Action	Readily implementable. Dependent on continued DOE ownership of property.	Short-term risk to remediation workers. Long-term risk reduced by continued operation of existing treatment facilities.	No risk to environmental indicators.	Does not meet all RAOs and preliminary ARARs.	1,490	2.87 x 10^{-4}	690,000	0/10,971
3 - Oxidant Injection, VER, and Phytoremediation	Readily implementable. Proven and reliable technology.	Short-term risk to remediation workers. Long-term risk minimized by reduction of contaminant concentrations.	No risk to environmental indicators.	Can meet all RAOs and preliminary ARARs.	120	6.35 x 10^{-6}	326,000	9,167/7,218
4 - VER and Steam Stripping	Readily implementable. Processes have been demonstrated to be reliable.	Short-term risk to remediation workers. Long-term risk minimized by reduction of contaminant concentrations.	No risk to environmental indicators.	Can meet all RAOs and preliminary ARARs with the exception that COCs may impact surface water.	14.4	2.77 x 10^{-6}	200,000	10,516/16,003
5 - VER	Readily implementable. Process had been demonstrated to be reliable.	Short-term risk to remediation workers. Long-term risk minimized by reduction of contaminant concentrations.	No risk to environmental indicators.	Can meet all RAOs and preliminary ARARs.	25.9	4.98 x 10^{-6}	180,000	2,348/17,665
6 - Groundwater Extraction and Bioremediation	Readily implementable. Process had been demonstrated to be reliable.	Short-term risk to remediation workers. Long-term risk minimized by reduction of contaminant concentrations.	No risk to environmental indicators.	Can meet all RAOs and preliminary ARARs.	22.5	4.33 x 10^{-6}	263,000	2,781/15,503
7 - Oxidant Recirculation	Readily implementable. Use of proven and reliable technology coupled with demonstrated in situ method.	Short-term risk to remediation workers. Long-term risk minimized by reduction of contaminant concentrations.	Potential for oxidant migration to surface water initially disrupting ecological receptors but is not expected to result in permanent effects.	Can meet all RAOs and preliminary ARARs.	25.8	5.16 x 10^{-6}	120,000	1,560/17,315

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Addendum to

Quadrant II
Cleanup Alternatives Study/Corrective Measures Study

for

Portsmouth Gaseous Diffusion Plant
Piketon, Ohio

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Prepared by
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EXECUTIVE SUMMARY

Upon review of the Quadrant II Cleanup Alternatives Study/Corrective Measures Study (CAS/CMS) Final Report (DOE 2001), Ohio Environmental Protection Agency (EPA) suggested that several additional alternatives for the remediation of the X-701B Holding Pond and Retention Basin soils be considered prior to selection and implementation. This addendum describes the development and analysis of four additional remedial alternatives, as identified by Ohio EPA in a letter dated August 31, 2001, for the soils associated with the X-701B Holding Pond and Retention Basins. These additional alternatives are variations of the three originally proposed alternatives. In addition, the cost estimate for Alternative 1 has been recalculated with updated information and presented as Alternative 4 for comparison with the new alternatives.

The additional remedial alternatives for soils at the X-701B Holding Pond and Retention Basins are as follows:

- Alternative 4 - Institutional Controls

  This alternative is identical to the original Alternative 1, only with associated costs updated. It includes deed restrictions to limit land development and access controls to prevent exposure to contaminated soils.

- Alternative 5 - Institutional Controls and Removal

  The pond and retention basins will be excavated to the water table (maximum 15 ft depth) to remove contaminants exceeding preliminary remedial goals (PRGs). The horizontal limits of excavation will extend 2 ft beyond the edges of the retention basins and 10 ft radially from sampling locations, including outlying sample locations, where contaminants exceed PRGs in soil. The excavated area will be partially backfilled, as needed, and graded to drain into the existing drainage ditch north of the holding pond. The soil excavated will be containerized and shipped off-site for disposal as low-level radioactive waste (LLW). Soil from beneath the X-701B Holding Pond will be segregated and shipped off-site as mixed (hazardous and LLW) waste. An existing storm sewer will be modified to drain into the excavation area and the drainage ditch. The existing monitoring, injection, and extraction wells and X-701E Neutralization Building will be relocated. Institutional controls include deed and access restrictions.

- Alternative 6 - Institutional Controls, Select Removal, and Capping

  An engineered cap meeting Resource Conservation and Recovery Act (RCRA) Subtitles C and D and Ohio Hazardous Waste and Solid Waste requirements will be placed over the pond and basins. The cap will extend 25 ft beyond the limits of the pond and basins. Outside of the capped area, soils that have contamination exceeding PRGs will be excavated (maximum excavation depth of 15 ft) and placed under the cap. The existing drain piping located in the holding pond will be abandoned in place and the drain pumps removed. The existing monitoring, injection, and extraction wells and X-701E Neutralization Building will be relocated. The existing storm sewer will be re-routed to the north of the capped area. Institutional controls include deed and access restrictions.

- Alternative 7 - Institutional Controls and On-Site Disposal

  Excavate the holding pond and retention basins to a maximum depth of 15 ft and horizontal limits of excavation extending 2 ft beyond the holding pond and retention basins. In addition, excavate surrounding areas that have been identified as exceeding the established PRGs to a maximum depth of 15 ft. The excavation resulting from the removal of the holding pond and the East Retention Basin will be converted to an engineered disposal cell, with a leachate collection system, a liner system, and an engineered cap sized to encompass the entire excavated area. The disposal cell will have the capacity to accept all the excavated materials from the X-701B Holding Pond and Retention Basin area. The existing monitoring, injection, and extraction wells and X-701E Neutralization Building will be relocated. Institutional controls include deed and access restrictions.

- Alternative 8 - Institutional Controls, Select Removal, and Capping with Piping System

  This alternative is the same as Alternative 6 above, with the exception that the existing drain pumps located in the holding pond will remain in place and additional piping will be installed for use with the existing piping system in a possible future remediation system, such as oxidant injection.

Table ES.1 summarizes the relative effectiveness and costs for the additional alternatives evaluated for soils at the X-701B Holding Pond and Retention Basins.

Alternative 4 will not meet all Remedial Action Objectives (RAOs) because contaminant concentrations will not be reduced below established leaching levels. Alternatives 5, 6, 7, and 8 minimize both long-term and short-term risks to human health and the environment and will meet RAOs by eliminating the exposure pathway and reducing contaminant concentrations. All of these alternatives can be readily implemented and have been proven reliable and effective.

Table ES.1. Summary of Alternative Analysis for X-701B Holding Pond and Retention Basins soils

Alternative	Technical Analysis	Human Health Analysis	Environmental Analysis	Institutional Analysis	Capital Cost Analysis (Present Worth - $1,000s)	O&M Cost (Present Worth - $1,000s)
4 – Institutional Controls	Readily implementable. Deed restrictions and existing fencing would be reliable if site controls are maintained.	No short-term risk. Long-term exposure to on-site workers.	No risk to environmental indicators.	Does not meet all RAOs and preliminary ARARs.	229	98
5 – Institutional Controls and Removal	Implementable with consideration needed for wind-blown radioactive dust. Removal of construction debris and associated soil.	Short-term risk to remediation workers, including significant health physics concerns caused by wind-blown radioactive dust. Long-term risk eliminated through elimination of the pathway.	No risk to environmental indicators. Could initially disrupt ecological receptors, but is not expected to result in permanent effects.	Can meet all RAOs and preliminary ARARs.	28,267	98
6 – Institutional Controls, Select Removal, and Capping	Readily implementable. Relocation of select soil followed by capping the retention basin and holding pond areas.	Short-term risk to remediation workers. Long-term risk eliminated through elimination of the pathway.	No risk to environmental indicators. Could initially disrupt ecological receptors, but is not expected to result in permanent effects.	Can meet all RAOs and preliminary ARARs.	4,343	98
7 – Institutional Controls and On-site Disposal	Implementable with consideration needed for wind-blown radioactive dust. Disposal of contaminated soil in a lined disposal cell.	Short-term risk to remediation workers, including significant health physics concerns caused by wind-blown radioactive dust. Long-term risk eliminated through elimination of the pathway.	No risk to environmental indicators. Could initially disrupt ecological receptors, but is not expected to result in permanent effects.	Can meet all RAOs and preliminary ARARs.	9,581	98
8 – Institutional Controls, Select Removal, and Capping with Piping System	Readily implementable. Relocation of select soil followed by capping the retention basin and holding pond areas.	Short-term risk to remediation workers. Long-term risk eliminated through elimination of the pathway.	No risk to environmental indicators. Could initially disrupt ecological receptors, but is not expected to result in permanent effects.	Can meet all RAOs and preliminary ARARs.	4,391	98

ARARs = Applicable or Relevant and Appropriate Requirements

O&M = operation and maintenance

Attachment 2
Quadrant II CAS/CMS Alternative 8 (Oxidant Injection) For The X-701B Groundwater Area

QUADRANT II
CLEANUP ALTERNATIVES STUDY/CORRECTIVE MEASURES STUDY (CAS/CMS)
ALTERNATIVE 8 (OXIDANT INJECTION)
FOR THE X-701B GROUNDWATER AREA

1. INTRODUCTION

This document outlines an additional remedial alternative for groundwater to supplement the Quadrant II Cleanup Alternatives Study (CAS)/Corrective Measures Study (CMS) Final Report (dated February 28, 2001) and Addendum (dated November 2001) for the Portsmouth Gaseous Diffusion Plant (PORTS) Piketon, Ohio. Under this remedial alternative, called Alternative 8, corrective actions will be performed to remediate the X-701B Groundwater Area, as shown in Figure 1. An evaluation of the effectiveness of these groundwater remedies will be conducted during the phased implementation and as part of the five-year review process using the U.S. Environmental Protection Agency (EPA) Comprehensive Five-Year Review Guidance, EPA 540-R01-007/OSWER No. 9355.7-03B-P, June 2001. Concurrent with development of remedial alternatives, an environmental assessment addressing corrective measures alternatives at Quadrant II is being conducted to satisfy National Environmental Policy Act (NEPA) requirements.

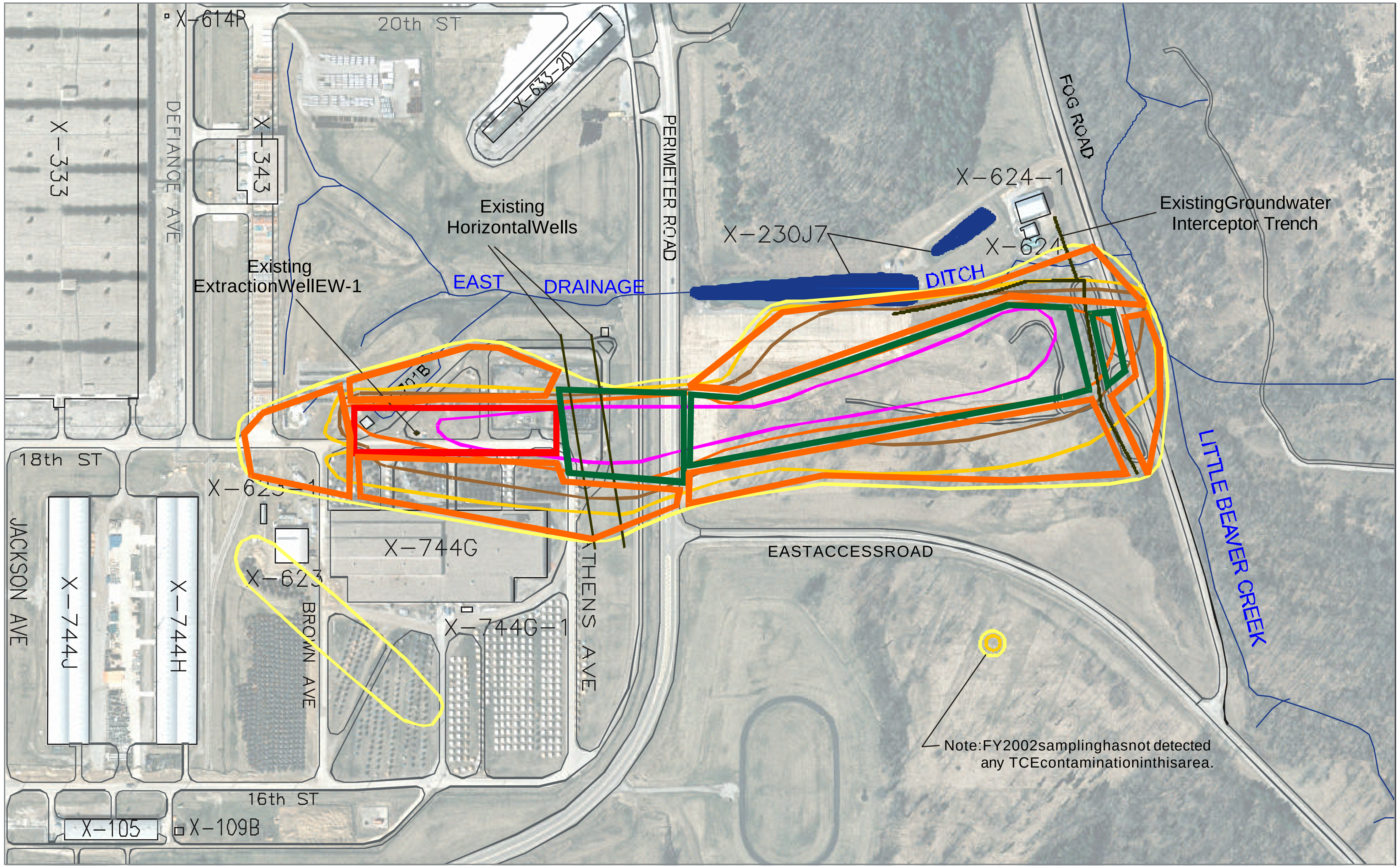
Alternative 8 is presented to accelerate groundwater remediation through in situ destruction of contaminant mass in both the source area and plume core. Alternative 8 is similar to Alternative 7 in the CAS/CMS report, except that oxidant recirculation has been replaced with:

- Oxidant injection,
- Followed by Electric Resistance Heating (ERH) in areas where residual contamination sources remain in low permeability soils, and
- The area of application for the remedy at the X-701B Groundwater Area has been expanded.

This alternative includes aggressive actions in the vicinity of the groundwater area also identified as requiring a corrective action for soils (see Chapter 6 of the Quadrant II CAS/CMS Final Report and the Addendum). The U.S. Department of Energy (DOE) requests that a decision on the particular corrective action for soils, (e.g., an engineered cap) be delayed until evaluation of the performance of the groundwater actions is completed. Evaluation of groundwater quality in the vicinity of the X-701B Holding Pond and Retention Basins will be performed as part of a five-year review.

Alternative 8 includes implementation of aggressive remedial technologies in the X-701B Groundwater Area for source control and plume reduction as follows:

- To address the majority of contamination in groundwater:
  - An oxidant solution will be injected in suspected source areas of the western portion of the groundwater plume (west of Perimeter Road),
  - An oxidant solution will be injected along the plume core (east of Perimeter Road), and
  - An oxidant solution will be injected in the plume periphery.
- Following completion and evaluation of oxidant injection, residual contamination sources remaining in low permeability soils will be addressed as follows:
  - ERH will be utilized to address residual contamination sources in low permeability soils, as required.
- Existing groundwater extraction well EW-1 will be placed in service and operated as needed, and
- The Interim Remedial Measure (IRM) trench is expected to continue operation until Remedial Action Objectives (RAOs) are met.



Site Location Map

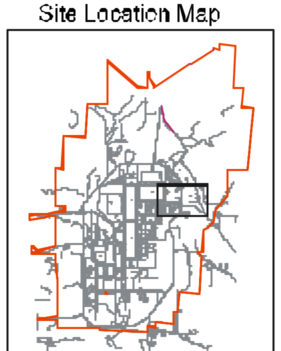


Photo circa 1995

Plume Periphery

Building

Water

Existing Remediation Systems

Source Area

Plume Core Areas

TCE Color Ramp Legend (ug/L)

100000+

10000-99999

1000-9999

100-999

5-99

Based on July/August 2001 analytical data

0 125 250

GRAPHIC SCALE IN FEET

Pro2Serve Technical Solutions

PRO2SERVE OAK RIDGE, TENNESSEE

Fig. 1

Alternative 8 - X-701B Groundwater Area
Source and Plume Core Areas

DWN BY: DER	DRAFT CHK: JCS	PROJECT ENGR: JDR
PROJECT NO. Quad II CMS Alternative 8	DRAWING ID. X-701B GW Alt 8f.cdr	DRAWING DATE June 24, 2002 JCS

Long-term institutional controls via land use restrictions will be developed and implemented to prevent exposures to groundwater if residual contamination above RAOs remains after remedial activities are completed.

Soil sampling and groundwater monitoring will be used to evaluate and optimize the performance of the oxidant injection. If monitoring results show that oxidant injection is not effective in meeting RAOs, then ERH in conjunction with soil vapor extraction will be initiated. This heating technique is being demonstrated this year at the Paducah Gaseous Diffusion Plant. If prior to installation of ERH, other technologies (such as Vacuum Enhanced Recovery (VER) or an enhanced oxidant delivery system) are determined to be appropriate, these technologies will be implemented to achieve RAOs (see Figure 2).

Estimates of contaminant mass removal and evaluation of contaminant concentration trends will provide key performance metrics for the remedy. Groundwater monitoring will continue after treatment activities are completed to assess the effectiveness of the remedy in meeting the RAOs.

All groundwater remediation activities entail varying levels of uncertainty regarding effectiveness and the timeframe for cleanup. Alternative 8 is expected to be an effective method for addressing the residual Dense Non-Aqueous Phase Liquids (DNAPL) high concentration plume core. As stated above, performance-monitoring data will be used to assess its effectiveness in meeting the RAOs. In the event that the in situ chemical oxidation technology is unable to meet the performance goals necessary to attain the RAOs, the secondary remedy, ERH will be implemented. Design efforts will include the development of a performance-monitoring plan. A key objective of this plan will be to identify the specific criteria (e.g., percent removal or time-averaged concentration trends) needed to assess the effectiveness of the technology, which in turn would support a decision regarding the need for a contingent remedy.

2. TECHNICAL ANALYSIS

This technical analysis is presented to provide basic design information that will facilitate alternative evaluation. A summary of the alternative follows:

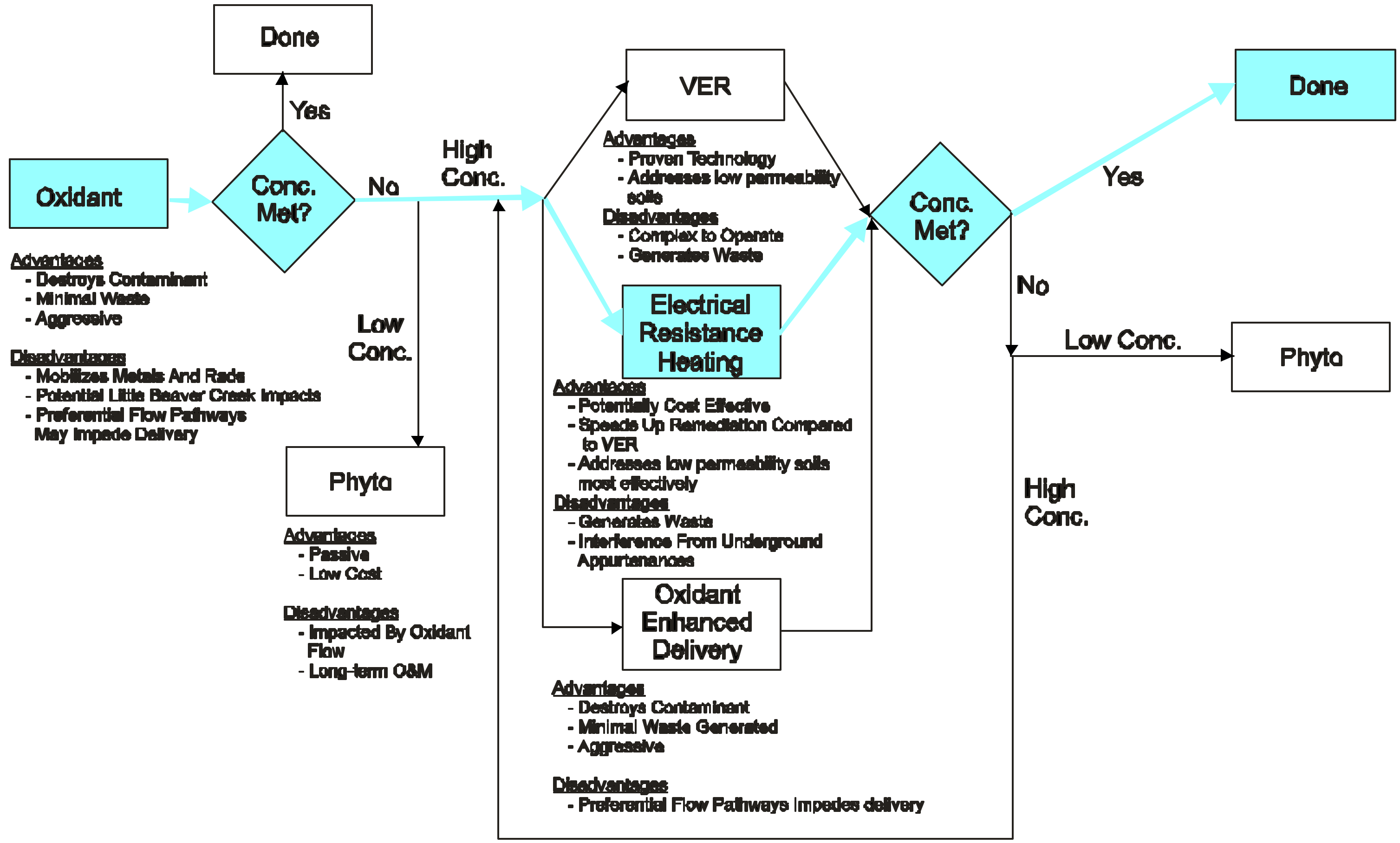
(1) The oxidant injection system will be implemented through a phased construction approach. The oxidant injection system is expected to operate for an estimated 2-year period (the system is not expected to operate during freezing conditions). The oxidant injection system includes:

- Oxidant injection over an approximate 1-acre area extending from the western end of the highest concentration portion of the plume to the east end of 18th Street. This treatment area includes the suspected source area. The area includes the southwest portion of the former X-701B Holding Pond, the area where the oxidant treatability test was installed in late 2001, and an area beneath the southwest corner of the X-747G Precious Metals Storage Yard.

- Planned injection of oxidant into the two existing horizontal wells just west of Perimeter Road.

- Planned oxidant injection over an approximately 4.5-acre area coinciding with the plume core between Perimeter Road and the IRM trench.

- Injection of oxidant is also planned to be performed in the plume periphery via existing monitoring wells and several new wells whose location and number is to be determined in the system design. Oxidant will be injected into wells completed in the Gallia sand and gravel.



Proposed Alternative Oxidant Injection Followed by Electrical Resistance Heating, if needed, as a Preferential Path Forward for Remediation of Residual Concentration.

Fig. 2	Oxidant Injection and Contingent Remediation Activities Decision Tree	DOCUMENT ID:	DRAWING ID: Decision Tree.cdr	DRAWING DATE: June 24, [illegible] SLC

(2) The ERH system will be:

- Implemented in low permeability source areas following completion and evaluation of oxidant injection.

- Implemented in areas if rebound of contaminant concentrations occurs following oxidant injection and evaluation.

(3) The groundwater extraction system is expected to include:

- One existing extraction well (EW-1) extending approximately32 ft. below ground surface in the vicinity of the former X-701B Holding Pond, operating as needed to extract DNAPL.

- Extracted groundwater will be treated in the existing X-623 Groundwater Treatment Facility. If DNAPLs are recovered, they will be removed at the X-701E building DNAPL separator.

(4) Monitoring will be conducted at selected existing wells. Additional monitoring wells may need to be installed to support remedial evaluation. Soil sampling (pre- and post-treatment) will be used to support mass removal calculations.

(5) The X-701B IRM trench will continue during the 2-year period of oxidant treatment. Continued operation of the IRM trench will depend on the post-treatment groundwater concentrations and whether operation is needed to meet the remedial action objectives.

(6) The X-701B sump used to drain surface runoff/precipitation will continue to operate until the soils remedy for the holding pond and adjacent areas is implemented.

(7) The X-700 Chemical Cleaning Building and X-705 Decontamination Building sumps will continue to operate. Operation of the sump pumps minimizes the interaction between the 7-Unit plume and the X-701B plume and is part of the design basis for the remediation of the X-701B plume.

(8) Institutional controls are expected to be consistent with the current DOE site land use and will consist of continued DOE access restrictions. For the purposes of this alternative analysis, it was assumed that the X-701B site will remain under government control and that long-term land use will be restricted industrial.

2.1 Performance

Under this alternative, contaminant mass will be destroyed and transformed into innocuous substances such as carbon dioxide, water and inorganic chloride. The magnitude of groundwater contamination and total volume of contaminated groundwater will be reduced as mass is destroyed through in situ treatment and remaining residual dissolved-phase contamination is attenuated through natural processes (such as diffusion and dispersion). Oxidant injection is considered an emerging technology; however, there have been several field pilot tests of the technology at PORTS that have established its applicability to the site. The addition of ERH will enhance the removal of residual source material to facilitate the achievement of RAOs.

RAOs are expected to be met in the source and plume core areas within five years of completion of injection and ERH in the plume core. Oxidant injection in the plume periphery will be conducted using multiple portable injection equipment; injection wells will be spaced such that RAOs are expected to be met in the order of 10 to 30 years. The oxidant and the injection technologies employed will be determined during the system design. The design of the injection system will be based on the objectives of eliminating residual DNAPL in the source area and attaining RAOs as quickly as possible, while remaining cost-effective. Modeling and/or calculations will be completed to generate an estimate of the cleanup timeframe, which would be updated as the remediation progresses and performance data are collected. The chemical oxidation of trichloroethene (TCE) will be quite rapid once the oxidant contacts the contaminant. The overall timeframe for cleanup will depend on the injection spacing and the extent to which oxidant transport is limited by advective groundwater velocities or diffusion. In order to accomplish the cleanup as quickly as possible, the injection will be designed to minimize the reliance on diffusive transport. Remediation of the less permeable zones in the subsurface will unavoidably entail diffusive transport and thus are expected to be the rate-limiting steps in the overall schedule for cleanup.

ERH technologies have been tested and implemented at several locations with site features similar to PORTS. ERH technologies consist of multiple arrays of vertical electrodes connected to a power source. Each array consists of multiple conducting electrodes in a pattern surrounding a neutral electrode. Arrays are expected to be 30 ft. to 40 ft. in diameter. Conducting electrodes require injection of a small quantity of an electrolytic solution. Upon application of a current, soil heating occurs between the electrodes. Electric current (heating) is computer controlled via installed temperature monitors. This technology provides more uniform heating of heterogeneous sedimentary materials than other delivery system driven technologies, such as steam stripping.

In implementing ERH, several weeks is required to increase the temperature of the soil and contained fluids to about 80^{o} C, the volatilization point of TCE in the form of DNAPL. Heating is maintained for a sufficient time to volatilize the expected DNAPL. Once volatized TCE is extracted using vapor recovery technology such as soil vapor extraction (SVE) wells. Boreholes equipped with electrodes will also include SVE wells. Additional SVE wells may be installed to augment TCE recovery. Recovered vapors are collected or destroyed in an above ground treatment system, which may consist of vapor phase carbon or catalytic oxidation equipment. Heating of the subsurface to the point of volatilization of TCE will enable recovery via SVE. RAOs are expected to be met in the application area within five years of completion of heating. Due to the size of the source area, it may be subdivided into multiple sub-areas, each requiring heating over subsequent time periods. If RAOs are not met, technologies such as phytoremediation or modifications of other currently utilized technologies will be evaluated and implemented as necessary.

The X-701B Groundwater Area will be evaluated after five years of implementation of the alternative. Land use restrictions, in combination with groundwater treatment is expected to reduce the likelihood of exposure of current and future on-site workers and the general public to contaminated groundwater.

2.2 Reliability

Previous actions at PORTS for oxidant injection indicate that hydrogen peroxide, sodium permanganate, or potassium permanganate oxidant can be effectively delivered to the lower Minford clayey silt, the Gallia sand and gravel, and fractures in the top of the Sunbury shale. Oxidants have been proven to be effective in the destructive treatment of dissolved trichloroethene (TCE), the primary contaminant in the X-701B plume. The performance of the technology is evaluated through soil and groundwater-sampling techniques, allowing for refinements or optimization of the treatment processes as needed in response to actual site conditions.

Elimination of above ground collection, handling, storage and treatment of contaminants and treatment residuals simplifies the implementation of this remedy, enhancing its overall reliability.

The use of the evaluated technologies has been proven reliable at other sites. ERH has been shown to effectively heat the saturated and unsaturated soils with uniform heating of heterogeneous sedimentary materials such as clays and the upper portion of the Sunbury shale.

Groundwater monitoring will be used to determine the effectiveness of this alternative. Trained personnel will inspect and sample the groundwater monitoring wells. Maintenance of monitoring point wellheads will be relatively straightforward and can be successfully performed by PORTS personnel. Labor and materials required to maintain the monitoring point wellheads are expected to be readily available for at least 30 years.

2.3 Implementability

Installation of the oxidant injection system will be completed using standard drilling and construction equipment that is readily available. Oxidant delivery systems will utilize existing wells and other technologies such as prefabricated vertical wells. The actual injection technology will be determined during system design. The injection schedule will be flexible and designed to incorporate lessons learned as the program continues.

Installation of the ERH system will be performed using special techniques for constructing electrodes currently available through a limited number of contractors. The vapor recovery technology requires standard equipment that is readily available and because of the shallow depth to contamination is easily implementable at PORTS.

Because the U.S. Government is expected to occupy the site for the indefinite future, no additional deed and land use restrictions are required. Additional restrictions could be established if the status of the site changes in the future. Fugitive dust emissions must be considered and monitored for all construction activities. Adequate access is available to all affected areas.

2.4 Safety

Some safety hazards are expected to be encountered during construction activities. These hazards are not expected to be any greater than those experienced in private industry for operation of similar equipment.

Safety hazards present during operations include use of high voltages with potential for burns and electrical shock within the area of application of ERH. Additional hazards with ERH include the potential creation of steam and its migration.

Oxidant injection systems will include the delivery, storage, and use of a strong oxidizing agent. A project health and safety plan will address the safe handling of chemical usage.

Potential hazards to workers at the site will be mitigated through compliance with Occupational Safety and Health Administration (OSHA) regulations and a site-specific health and safety plan. This plan will address the potential hazards associated with chemical hazards and heavy equipment use, such as drilling and excavating equipment, and other equipment, such as power generators, so as to minimize the risk to remediation workers. Utilities that pose a hazard to workers will be deactivated before construction. Such activities will be coordinated with adjacent facility operations to assure that potential worker hazards from other operations are minimized.

Implementation of this alternative is expected to pose no safety hazards for neighboring populations since the contaminants will remain on-site.

3. HUMAN HEALTH ANALYSIS

3.1 Short-Term Exposure Risks

The short-term exposure risks associated with implementation of this alternative will involve the potential for increased exposure of on-site workers (remediation workers) to contaminants during remedial system installation and monitoring activities. The associated risks will be minimized with implementation of, and adherence to, health and safety plans and as-low-as-reasonably-achievable (ALARA) principles.

In situ destruction of the contaminants minimizes the need for above ground collection, handling, treatment, and disposal of contaminants or treatment residuals. Minimization of these activities significantly reduces the short-term exposure risks to on-site workers.

Risks from operation and maintenance (O&M) activities should be no greater than risks incurred in private industry for comparable types of labor. Implementing this alternative should pose no short-term risk to neighboring populations because activities will be performed on-site.

3.2 Long-Term Exposure Risks

Long-term exposure risks fall within the acceptable range of risk since remedial actions will destroy or remove a significant mass of TCE, reducing the contamination levels of the plume. Ecological receptors are not expected to be impacted because migration of groundwater contamination to surface water bodies will be prevented by operation of the interceptor trench. Land use restrictions will prevent development of the Gallia sand and gravel as a drinking water source in the area. The long-term exposure risks associated with this alternative are acceptable because the remedial action is expected to satisfy the RAOs.

4. ENVIRONMENTAL ANALYSIS

Based on previous evaluations of similar activities, Alternative 8 has been determined to pose negligible risks to ecological receptors in the area and will have no adverse effects on wetlands, archeological and cultural resources, or critical habitat for threatened and endangered species. Use of oxidants will be managed to avoid any potential discharge of residual oxidants to wetland areas.

No adverse or beneficial influences on flood elevations will result because Quadrant II is not located in a 100- or 500-year floodplain.

No socioeconomic effects on the local community are anticipated from implementation of this alternative. The long-term risks associated with this alternative are not an issue because the baseline ecological risk assessment (BERA) states that, in its current condition, PORTS does not affect ecological receptors in Quadrant II.

5. INSTITUTIONAL ANALYSIS

Appendix B of the Quadrant II CAS/CMS Final Report provides a preliminary list of federal and state applicable relevant and appropriate requirements (ARARs) and other guidance that will potentially be considered for the remediation of the X-701B Groundwater Area. This alternative is expected to reduce contaminant concentrations to below Preliminary Remediation Goal (PRGs) where practicable and expected to meet RAOs.

6. COST ANALYSIS

The estimated costs associated with Alternative 8 are provided in Table 1. The basis for the estimate is presented below.

- The oxidant injection system in the source area is expected to include:
  - Installation of approximately 30 Gallia injection wells extending from the base of the Gallia (top of the Sunbury shale) to the lower unit of the Minford.
  - Installation of a planned infiltration gallery to inject oxidant in to the Minford near the zone of saturation.
- Planned oxidant injection over an approximately 4.5-acre area coinciding with the plume core between Perimeter Road and the IRM trench. The plume core oxidant injection system will include:
  - Installation of approximately 30 deep injection wells extending to the bottom of the Gallia.
  - Estimated screen length of deep injection wells is 20 ft., dependent on field conditions.
  - Planned installation of an infiltration gallery to inject oxidant into the Minford near the zone of saturation.
- The ERH system in this area will include:
  - Installation of multiple heating arrays, each containing up to six heating electrodes and one neutral electrode. The heating zone will extend from the lower Minford into the top of the Sunbury shale.

- Installation of a vapor recovery and treatment/collection system.

7. COMPARATIVE EVALUATION OF ALTERNATIVES

Direct comparisons between alternatives illuminate the advantages and disadvantages of one alternative over another. The same criteria as used in the detailed analysis are used for the comparative evaluation:

- technical analysis,
- human health analysis,
- environmental analysis,
- institutional analysis, and
- cost analysis.

Table 1. Summary of Costs for X-701B Groundwater Area, Alternative 8
Portsmouth Gaseous Diffusion Plant, Piketon, Ohio

Quadrant II CAS/CMS Alternative 8	Capital Cost ($ thousands)		O&M Cost ($ thousands)	
	Cost	Present Worth[a]	Cost	Present Worth[a]
General Requirements	1,531			
Oxidant Injection	10,808			
Electrical Resistance Heating	1,950			
Operations and Maintenance			5,495 (yr 1 – 10) 7,878 (yr 11 – 30)	
Base Actions Totals	**14,289**	**13,969**		**9,972**

[a] Costs are escalated per DOE guidance. Present worth costs for the study period calculated using discount rate of 5.8%.

This comparative evaluation compares Alternative 8 to previous alternatives presented in the Quadrant II CAS/CMS Final Report.

7.1 Technical Analysis

7.1.1 Performance

Alternative 1 was determined not to be effective in reducing exposures to contaminants. Alternative 2 was determined to be effective at reducing exposure to contaminants, but does not meet the RAOs. Alternatives 3 through 8 were determined to be effective in reducing the toxicity, mobility, and volume of contamination by eliminating and/or containing the source. Alternatives 3 through 8 are expected to be capable of meeting the RAOs. Alternative 8, which most fully utilizes an in situ treatment technology, minimizes possible contact with contaminants and the possibility to further spread them through releases. The X-701B Groundwater Area will be re-evaluated during the five year review.

7.1.2 Reliability

Alternative 2 relies on deed and land use restrictions to prevent exposure and direct contact with the contaminants. Deed and land use restrictions will reduce the potential for exposure to contaminated soil.

Alternatives 3 through 8 are reliable alternatives for removal of contaminants. These alternatives will require some O&M efforts to maintain their effectiveness. The greater O&M required for VER and steam stripping is offset by the shorter duration of these processes.

Alternatives that minimize mechanical operation tend to be more reliable. Alternatives utilizing VER and steam stripping will be less reliable because the systems require mechanical heating or extraction and vapor control.

7.1.3 Implementability

Alternatives 1 and 2 require no additional remedial activities and are the most easily implemented, requiring the least amount of time to implement.

Alternative 3 uses oxidant injection, VER, and phytoremediation to remove and treat contaminated groundwater. All three technologies have been implemented in a variety of hydrogeologic settings and are readily implementable. The time required to implement Alternative 3 is approximately 12 to 24 months.

Alternative 4 uses VER and steam stripping to eliminate contamination in selected areas of the X-701B Groundwater Area plume during the first two years. This is followed by groundwater extraction. All of these technologies have been demonstrated to remediate contaminated media at PORTS and other facilities. This alternative is readily implementable and the time required to implement Alternative 4 is approximately 12 to 24 months.

Alternative 5 uses VER to eliminate contamination in selected areas of the X-701B Groundwater Area plume during the first two years, followed by groundwater extraction. These technologies have been demonstrated to remediate contaminated media at other facilities. This alternative is readily implementable and the time required to implement Alternative 5 is approximately 10 to 18 months.

Alternative 6 uses groundwater extraction and bioremediation to eliminate contamination in selected areas of the X-701B Groundwater Area plume during the first two years, followed by groundwater extraction. Groundwater extraction has been demonstrated to effectively control and remediate contaminated media at PORTS and other facilities. Feasibility testing conducted on PORTS groundwater indicates that bioremediation may be effective for remediating contaminated groundwater. This alternative is readily implementable and the time required to implement Alternative 6 is approximately 10 to 12 months.

Alternative 7 uses oxidant injection and recirculation to eliminate contamination in the X-701B Groundwater Area plume for 6 months. Current studies indicate that oxidant injection will be effective for remediating contaminated groundwater. This alternative is readily implementable and the time required to implement Alternative 7 is approximately 15 to 24 months.

Alternative 8 uses oxidant injection followed by ERH to expedite remediation of the core plume and residual source areas. The oxidant injection technology has been successfully deployed in a variety of hydrogeologic settings, and is readily implementable at X-701B. Optimal methods for delivery of oxidant into the subsurface will be defined during design. This alternative will reduce the concentration of contaminants more quickly than any of the other alternatives evaluated. The time required to implement Alternative 8 is approximately 15 to 24 months.

7.1.4 Safety

Alternatives 1 and 2 pose the least safety risks. The implementation of any of Alternatives 3 through 8 will pose the greatest safety risks to workers during construction activities because these alternatives require remediation efforts within a contaminated area during which time workers could potentially be exposed to contaminated groundwater at treatment facilities.

Alternatives 3, 7, and 8 include the delivery, storage, and use of strong oxidizing agents.

7.2 Human Health Analysis

No short-term exposure risks to neighboring populations are associated with any of the alternatives. However, Alternatives 3 through 8 will present some short-term exposure risks to remediation workers and current on-site workers during construction activities.

Long-term risks are minimized with implementation of any of Alternatives 3 through 8 as a result of the reduction of groundwater contamination concentrations to levels that are within the acceptable risk range.

7.3 Environmental Analysis

Alternatives 3, 7, and 8 have been determined to pose negligible risks to ecological receptors in the area. It is expected that oxidant migration can be controlled and none of the alternatives should have any adverse effects on wetlands, archeological or cultural resources, or critical habitat for threatened or endangered species (these resources are not present in the X-701B Holding Pond and Retention Basins areas). Neither adverse nor beneficial influences on flood elevations will occur because Quadrant II is not located in a 100- or 500-year floodplain. No socioeconomic effects on the local community are anticipated from implementation of any of the alternatives.

7.4 Institutional Analysis

Alternatives 1 and 2 will not meet all of the preliminary ARARs identified in Appendix B of the Quadrant II CAS/CMS Final Report. Alternative 4 is expected to meet all preliminary ARARs and all RAOs with the exception that Contaminants of Concern (COCs) may impact surface water at X-230J7 Holding Pond. Alternatives 3, 5, 6, 7, and 8 are expected to meet preliminary ARARs and groundwater RAOs.

7.5 Cost Analysis

Alternatives estimated cost comparisons are presented in Table 2

Table 2. Summary of Alternative Analysis for the X-701B Groundwater Area Portsmouth Gaseous Diffusion Plant, Piketon, Ohio

Alternative	Technical Analysis	Human Health Analysis	Environmental Analysis	Institutional Analysis	30 Year Present Worth Costs ($1,000s) Capital/ O&M
1 – No Action	Readily implementable. Not effective at reducing exposure to contaminants.	No short-term risk. Long-term exposure to on-site workers and off-site population.	No risk to environmental receptors.	Does not meet all RAOs and preliminary ARARs.	0/0
2 – No Further Action	Readily implementable. Readily dependent on continued DOE ownership of property.	Short-term risk to remediation workers. Long-term risk reduced by continued operation of existing treatment facilities.	No risk to environmental receptors.	Does not meet all RAOs and preliminary ARARs.	0/10,971
3 – Oxidant Injection, VER, and Phytoremediation	Readily implementable. Proven and reliable technologies. Difficult due to combining multiple technologies..	Short-term risk to remediation workers. Long-term risk minimized by reduction of contaminant concentrations.	Potential for oxidant migration to surface water initially disrupting ecological receptors but is not expected to result in permanent effects.	Can meet all RAOs and preliminary ARARs.	9,167/7,218*
4 – VER and Steam Stripping	Readily implementable. Processes have been demonstrated to be reliable. Soil heterogeneities may reduce effectiveness of heating.	Short-term risk to remediation workers. Long-term risk minimized by reduction of contaminant concentrations.	No risk to environmental receptors.	Can meet all RAOs and preliminary ARARs with the exception that COCs may impact surface water.	10,516/16,003
5 – VER	Readily implementable. Processes had been demonstrated to be reliable. Presence of DNAPLs may extend cleanup period.	Short-term risk to remediation workers. Long-term risk minimized by reduction of contaminant concentrations.	No risk to environmental receptors.	Can meet all RAOs and preliminary ARARs.	2,348/17,665
6 – Groundwater Extraction and Bioremediation	Readily implementable. Process had been demonstrated to be reliable. Presence of DNAPLs may extend cleanup period.	Short-term risk to remediation workers. Long-term risk minimized by reduction of contaminant concentrations.	No risk to environmental receptors.	Can meet all RAOs and preliminary ARARs.	2,781/15,503
7 – Oxidant Recirculation	Readily implementable. Use of proven and reliable technology coupled with demonstrated in situ method.	Short-term risk to remediation workers. Long-term risk minimized by reduction of contaminant concentrations.	Potential for oxidant migration to surface water initially disrupting ecological receptors but is not expected to result in permanent effects.	Can meet all RAOs and preliminary ARARs.	1,560/17,315
8 – Oxidant Injection	Readily implementable. Proven and reliable technology.	Short-term risk to remediation workers. Long-term risk minimized by reduction of contaminant concentrations.	Potential for oxidant migration to surface water initially disrupting ecological receptors but is not expected to result in permanent effects.	Can meet all RAOs and preliminary ARARs.	13,969/9,972

*O&M costs do not include the cost of treatment of water from the X-705 Decontamination Building sumps and the IRM trench